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U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF SOILS—MILTON WHITNEY, Chief.

IN COOPERATION WITH THE KANSAS STATE AGRICULTURAL COLLEGE, H. J.
WATERS, PRESIDENT; KANSAS AGRICULTURAL EXPERIMENT STA-
TION, E. H. WEBSTER, DIRECTOR; AGRONOMY DEPART-
MENT, W. M. JARDINE, AGRONOMIST.

SOIL SURVEY OF GREENWOOD COUNTY, KANSAS.

BY

W. C. BYERS, OF THE U. S. DEPARTMENT OF AGRICULTURE,
AND N. S. ROBB AND J. P. STACK, OF THE KAN-
SAS STATE AGRICULTURAL COLLEGE.

HUGH H. BENNETT, INSPECTOR, SOUTHERN DIVISION.

[Advance Sheets—Field Operations of the Bureau of Soils, 1912.]



WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1914.

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,

Washington, D. C., November 29, 1913.

SIR: One of the soil survey projects completed during the field season of 1912 was the survey of Greenwood County, Kans. The work in Kansas is being carried on in cooperation with the State College of Agriculture and Experiment Station and the selection of this area was made after conference with the State officials.

I have the honor to recommend that the accompanying manuscript report and map covering this survey be published as advance sheets of Field Operations of the Bureau of Soils for 1912, as authorized by law.

Respectfully,

MILTON WHITNEY,
Chief of Bureau.

Hon. D. F. HOUSTON,
Secretary of Agriculture.

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MAP.

Soil map, Greenwood County sheet, Kansas.

SOIL SURVEY OF GREENWOOD COUNTY, KANSAS.

By W. C. BYERS, of the U. S. Department of Agriculture, and N. S. ROBB and J. P. STACK, of the Kansas State Agricultural College.

DESCRIPTION OF THE AREA.

Greenwood County is located in southeastern Kansas. It is in the fourth tier of counties from the Kansas-Missouri State line on the east and two counties lie between it and the Kansas-Oklahoma State line on the south. It is bounded on the north by Lyon and Chase Counties, on the east by Coffey, Woodson, and Wilson Counties, on the south by Elk County, and on the west by Butler County.

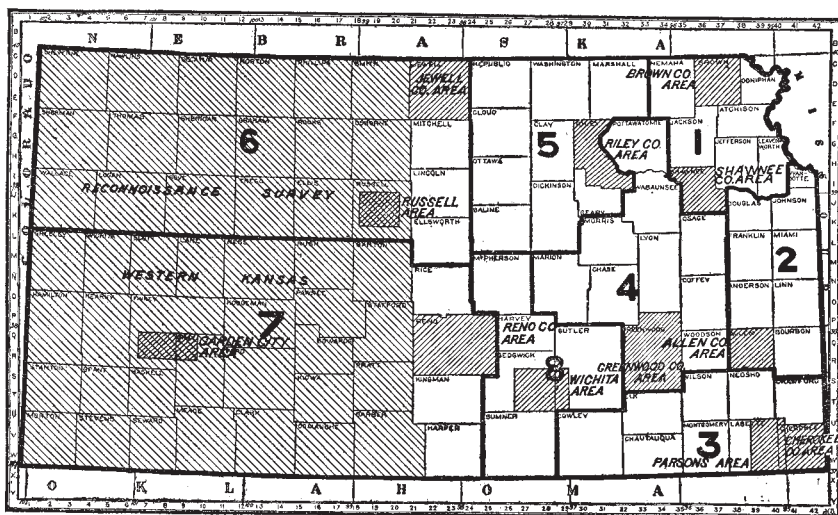


FIG. 1—Sketch map showing areas surveyed in Kansas.

Except for a section at the northwest corner, 6 miles wide by 9 miles long, where it is cut into by Chase County, the county is rectangular in shape. Its length from north to south is 39 miles and its width from east to west 31 miles. It comprises 1,158 square miles, or 741,120 acres.

Greenwood County lies in the Great Plains region. It is treeless, except for the uncleared stream bottoms, a few scattered trees near the edge of the bottoms, and some areas in the southeastern part of the county which support a very scrubby growth of oaks, principally blackjack. The uplands vary in topography from flat and undulating

to decidedly ridgy. The highest ridges are those in the western part of the county—the Flint Hills section (see Pl. I, figs. 1 and 2)—but there are conspicuous ridges and hills here and there throughout the county.

In detail the county comprises three general levels or divisions of benchlike configuration, each of which has been dissected to some extent by erosion. The lowest level is in the eastern part of the county and the highest in the western part.

There is a total range of elevation of about 600 feet. The lowest point, where the Verdigris River leaves the county, is about 900 feet, and the highest, in the Flint Hills along the western boundary, is over 1,500 feet above sea level. The range of elevation of the lowest division is from about 900 to 1,250 feet, of the middle division from 1,250 to 1,400 feet, and of the highest one from 1,400 to between 1,500 and 1,600 feet above sea level. Each level is quite distinct from the one lying adjacent to it, and the line separating them is marked usually by an escarpment or sharp slope, rising abruptly in many places 50 to 100 feet.

The highest of these divisions has the smallest and the lowest one the greatest extent. In fact, the larger part of the county is embraced in the latter. It includes all that part lying east of a line drawn approximately from Piedmont to Reece, thence northeast to a point about 6 miles east of Lapland, and thence almost due north to the county line, about 4 miles east of the northwest corner. The western boundary of the middle division, which is also the eastern boundary of the highest division, enters the county about 2 miles east of the southwest corner and runs northwest to a point about 7 miles north of the southwest corner, where it leaves the county, and again enters from the west 20 miles farther north and runs northeast to the corner of the offset of the county, and thence 2 miles north along the east side of the offset, where it swings west into the adjoining county. The eastern boundary of the middle division is much dissected by deep valleys of streams that flow from it out into the lower divisions.

Only the eastern edge of the highest level lies in Greenwood County, the greater part of it lying to the west of the county. It forms a high, relatively flat-topped plateau and is the main watershed of the region. Its streams, therefore, are small, as they head in it, and the valleys consequently shallow. The middle and highest divisions or levels are included in the Flint Hills.

The valleys along the streams of the lower division are broad. In the higher country of the Flint Hill section the valleys are narrow and covelike. The steepness of their walls has been accentuated by outcrops of the resistant limestone of this section. These rock

ledges add some degree of picturesqueness to an otherwise monotonous landscape.

As there has been no folding or faulting of the rocks, the surface features are the direct result of erosion. This has acted in proportion to the relative hardness of the interbedded sandstone, shale, and limestone of the region. The numerous and extensive shale horizons are characterized by flat or nearly level to undulating topography, which gives way to country of a more rolling surface where the underlying limestone has been exposed. In many places the uplands slope so gently to the bottoms that it is difficult to determine the exact boundary between them. In other places the slope is steeper and the boundary sharper, while in still other places the slope along the outer edge of the bottoms is sufficiently steep and dissected and often so stony as to have a rough character. By far the greater part of the area is topographically well suited for farming, the slope, with the exception of limited areas here and there, being gentle enough for plowing without attendant danger of erosion.

The drainage of the county is carried about equally by the Verdigris and Fall Rivers. The former rises in the adjoining county, crosses the north county line 5 miles from the northwest corner, and passes out of the county about 9 miles southeast of Neal. South Verdigris River, West Creek, and Walnut Creek, all rising within the county, are its main tributaries. Fall River rises in the western part of the county and flows southeast, leaving it a mile west of the southeast corner. Spring Creek, Otter Creek, and Salt Creek are its principal tributaries and drain the southwestern part of the county. Thurman Creek rises on the other side of the divide formed by the Flint Hills and flows northwest, leaving the county a mile from its northwest corner.

The first settlement in the territory in which Greenwood County is included of which there is any record was in 1856, by colonists from Mississippi. The first check to rapid settlement that the county had was in 1860, when many of the settlers abandoned their farms because of the drought. The only early trail through the county was that between Fort Scott and Wichita, and thus, being off the main line of travel to the west, the county was slower to be settled than some of the others. During 1861 a fort, which later gave rise to the town, was built where the town of Eureka now stands.

The county was organized in 1862 and the present boundaries established somewhat later. Most of the early settlers came from the northern States, Illinois, Indiana, Iowa, Ohio, and Pennsylvania furnishing quite a number, though there were also many from the Southern States, and in later years from Missouri Immigration

was stimulated by the construction of the Atchison, Topeka & Santa Fe Railway (then known as the Kansas City, Emporia & Southern) in 1879, and of the St. Louis, Wichita & Western, which is now a part of the Frisco system, the following year. The St. Louis, Fort Scott & Wichita, a part of the Missouri Pacific system, was put through the county in 1882. Greenwood and Charleston, early towns on the Verdigris and Fall Rivers, respectively, were depopulated when the railroads came through, the inhabitants moving to the newer towns along the railroads.

The population of the county, which is given by the Thirteenth Census as 16,060, is largely rural. Eureka, the county seat and the largest town, has a population of 2,333. It is located a little southwest of the center of the county on the Missouri Pacific Railway and a branch of the Santa Fe system running south from Emporia. Madison, the second largest town, has a population of 721 and is situated in the northern part of the county on the Verdigris River, the Atchison, Topeka & Santa Fe Railway, and a branch of the Missouri Pacific. Severy, nearly as large as Madison, is on the Santa Fe and Frisco lines, in the southern part, and Fall River, a town of 383 inhabitants, is located on the Frisco Railroad near the southeast corner of the county. Hamilton, on the Santa Fe Railway in the north-central part of the county, is of about the same size. Piedmont, on the Frisco; Reece and Neal, on the Missouri Pacific; and Quincy and Virgil, on the Santa Fe, are towns ranging in size from 200 to 600 inhabitants. Besides these there are small villages in various parts of the county.

There are about 125 miles of railroad in the county and all sections except the northwestern have fairly good shipping facilities. The Missouri Pacific crosses the county from east to west near its center, a branch of the Atchison, Topeka & Santa Fe traverses it centrally from north to south, and another branch of the same system follows along the Verdigris River in the eastern part of the county. A part of the Frisco system running between St. Louis and Wichita traverses the county from east to west near the southern boundary. A branch of the Missouri Pacific, known as the Interstate, running between Madison and Butler, Mo., traverses the northeastern part of the county.

Kansas City, about 160 miles northeast of the county, is the great live-stock and produce market of the region and is reached by all of the three railroads.

The wagon roads are in fairly good condition the greater part of the year. In the sections where pasture land predominates, the roads are scarce and travel is mostly by trails through the large pastures. The rural free delivery of mail is in operation in all parts of the county, and nearly all of the farmers and ranchers have telephones.

CLIMATE.

Greenwood County has a distinctly humid climate. The precipitation is relatively light from November to March, inclusive, and is heaviest during the crop-growing season, from April to October, inclusive. There is sometimes a deficiency of rainfall during the latter part of July and August, and the crops at such times may suffer unless special care is taken to conserve the moisture in the soil by proper cultivation. The winters are comparatively mild and open, although occasionally the temperature may fall below zero for a few days at a time. The average annual snowfall is about 10 inches. The snow is seldom deep and rarely remains on the ground for any length of time. The length of the growing season averages about 200 days.

The following tables, giving the normal monthly, seasonal, and annual temperature and precipitation and the dates of the first and last killing frosts at Lebo and Independence, represent the climatic conditions of Greenwood County:

Normal monthly, seasonal, and annual temperature and precipitation at Lebo, Kans.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
	° F.	° F.	° F.	Inches.	Inches.	Inches.	Inches.
December.....	34	74	— 6	1.5	1.1	1.6	3.3
January.....	29	72	—14	1.1	0.4	0.9	3.9
February.....	30	79	—26	1.6	1.8	1.3	6.4
Winter.....	31	.....	.....	4.2	3.3	3.8	13.6
March.....	42	92	3	2.5	2.3	2.5	1.6
April.....	56	96	20	3.2	3.6	3.0	1.4
May.....	65	98	31	5.4	1.0	10.3	0.0
Spring.....	55	.....	.....	11.2	6.9	15.8	3.0
June.....	74	104	43	5.7	3.1	10.0	0.0
July.....	78	109	48	4.0	2.1	4.9	0.0
August.....	77	106	43	4.6	2.2	12.6	0.0
Summer.....	76	.....	.....	14.3	7.4	27.5	0.0
September.....	69	104	32	4.3	3.4	5.8	0.0
October.....	58	93	25	2.7	1.1	2.7	0.3
November.....	42	88	2	1.6	1.1	2.4	0.4
Fall.....	56	.....	.....	8.6	5.6	10.9	0.7
Year.....	55	109	—26	38.2	23.2	58.0	17.3

Average date of first killing frost in autumn, Oct. 20; of last in spring, Apr. 12. Date of earliest killing frost in autumn, Oct. 9; of latest in spring, May 2.

Normal monthly, seasonal, and annual temperature and precipitation at Independence, Kans.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
	° F.	° F.	° F.	Inches.	Inches.	Inches.	Inches.
December.....	36	73	— 5	2.1	0.8	1.9	2.3
January.....	34	75	—16	1.5	1.5	1.2	2.9
February.....	33	78	—21	2.0	0.5	7.0	2.4
Winter.....	34	.....	.....	5.6	2.8	10.1	7.6
March.....	46	93	8	2.4	1.5	2.7	1.0
April.....	59	95	22	3.8	2.0	2.7	T.
May.....	68	98	31	4.8	3.9	6.6	0.0
Spring.....	58	.....	.....	11.0	7.4	12.0	1.0
June.....	77	105	45	4.9	3.8	11.3	0.0
July.....	81	111	54	4.3	3.2	2.5	0.0
August.....	80	110	43	3.0	4.6	0.8	0.0
Summer.....	79	.....	.....	12.2	11.6	14.6	0.0
September.....	73	109	34	3.7	0.7	9.1	0.0
October.....	61	95	26	2.6	1.5	6.3	T.
November.....	46	82	5	1.9	2.6	2.9	T.
Fall.....	60	.....	.....	8.2	4.8	18.3	T.
Year.....	57	111	—21	37.0	26.6	55.0	8.6

Average date of first killing frost in autumn, Oct. 26; of last in spring, Apr. 11. Date of earliest killing frost in autumn, Oct. 1; of latest in spring, May 20.

AGRICULTURE.

The history of agriculture in Greenwood County is similar to that of the whole western prairie region. The pioneers found a vast prairie covered with an exceedingly heavy mat of grasses, broken only by narrow wooded valleys along the larger streams. These forested areas furnished the natural location for their homes, as wood was available for buildings and fuel, and water was abundant. The valleys also offered protection from prairie fires and windstorms.

With the extensive free range covered with a luxuriant growth of nutritious prairie grasses, it is natural that stock raising should early have claimed the attention of settlers. Usually a few acres of bottom land near the houses were cleared and planted to corn. The cattle were raised and fattened largely upon the range and were sparingly fed with corn. Prior to the opening of the first railroad in 1879 the cattle were driven to Kansas City, where they were marketed.

With the passing of the free range, stock raising within inclosed pastures replaced the old method, and at present it is the most important industry in the county. As a large part of the county was exempted from homesteading by previous grants by the Government to railroads, to schools, and to the Osage Indians, the land was bought from these sources at a very nominal price and held in large bodies for grazing. Most of these ranches still exist, and only those whose topography and soil are especially suited for cultivation have been subdivided into smaller farms.

Wheat was one of the first crops tried by the pioneers. Mills for the grinding of wheat and corn were built along the streams in various parts of the county. Formerly spring wheat was more extensively grown than winter wheat, the census of 1870 showing the production of the former to be more than twice that of the latter. Since that year the production of spring wheat has steadily declined until at present there is none grown in the county, its susceptibility to rust and smut and its inability to withstand the summer droughts being probably largely responsible for the decline in production. Also, about this time the chinch bug became a serious pest and for a time entirely suppressed the production of this cereal. The largest production of wheat in the county is reported in the census of 1880, when there were sown 7,762 acres, which yielded a little more than 13 bushels to the acre. Shortly after this time the chinch bugs again became numerous, reducing the production of wheat to a place of minor importance. In the eastern part of the county, however, the growing of this cereal is again in favor, and at present the production is confined almost entirely to that section in the bottoms along the Verdigris River and Walnut Creek. The Thirteenth Census gives the crop as 33,136 bushels, or about 16 bushels to the acre. Most of the wheat is shipped from the county.

Wheat is usually sown from the middle of September to the first of October. Experience shows that the best yields are obtained from the early seedings. Wheat often follows wheat on the same ground for several years and often the seed is sown on poorly prepared ground. Sometimes wheat follows corn, in which case the ground is in many cases merely disked before seeding and the wheat sown between the rows of cornstalks. In most cases the plowing for wheat is shallow, often only 4 or 5 inches deep. The hard Turkey varieties, Turkey red and Kharkof, are most commonly grown and yield better than the soft wheats. Of the soft varieties, Zimmerman, Fultz, and Currell are the most prominent. As a general rule the hard wheats yield better on the uplands and the soft varieties in the bottoms, though they are used interchangeably.

Oats have also been grown since the early settlement of the county, and although the climatic conditions are not favorable to

their most profitable production, occasional large yields are secured. The sun frequently scalds the plant during its early growth, which emphasizes the importance of getting the seed in the ground as early as possible in the spring. The largest crop was that reported by the Thirteenth Census for the year 1909, being 129,237 bushels, grown on 5,248 acres.

Tobacco was introduced by the southern settlers, but its production has never attained more than local importance.

Sorghum also was grown by the early settlers for the manufacture of sirup for home use. During recent years the crop has also been grown for forage.

Flax was evidently introduced between the years 1870 and 1880, and has never gained an important place in the agriculture of the county. There were grown this year (1912) several small fields of flax, which yielded about 8 bushels of seed to the acre. The crop is thrashed, the seed marketed, and the straw fed to stock.

Broom corn was introduced prior to 1880, but never became an important crop and is not now grown.

Irish potatoes have been grown continuously since the early settlement of the county, and, although their production has steadily increased, the supply is insufficient to meet the local demand. Sweet potatoes have also been one of the minor crops since the early days.

Corn is and always has been one of the principal crops of the county. The crop has been grown in the same fields for many years, and in a few instances the same fields have produced corn year after year since the first settlement of the county. The crop is all consumed locally. Little effort has been made to improve the strains by seed selection, nor is any advantage taken of the desirable qualities of the established varieties for feeding. Some farmers select their seed from the crib, but more often not even this precaution is taken to secure good seed. Of the white varieties Boone County White and Johnson County White are favorites, and of the yellow sorts Reid's Yellow Dent, Hildreth, and Kansas Sunflower are preferred. There is about an equal quantity of the white and yellow varieties grown, and each is grown both on the bottom land and upland areas.

A part of the corn is drilled, both check-rowing and drilling in the row being practiced. A much larger part of the corn is listed, but unless the ground is plowed beforehand this method of planting allows the preparation of only a very poor seed bed and leaves the field in a succession of ridges and furrows, thus exposing a larger surface to the weather and increasing the evaporation of soil moisture.

For listed corn, cultivation begins when the corn is about 2 inches high. Usually the field is rolled first and the roller followed with the cultivator. This works the loose soil into the furrow and around the young plant, covering all weeds before they have made much growth.

After the second or third cultivation the surface is practically level. It is claimed for the listed corn that the deep planting insures greater protection against drought, but until the field is worked down flat there is too much surface exposed.

Modern machinery is in general use in cultivating corn. Weeders are used by some. The cultivators, both walking and riding, are usually of the 2-row type. The 2-row disk cultivator is the one most generally used, though the shovel cultivator is frequently seen. The corn harvester is in general use, though a large part of the crop is harvested by means of a sled on which a knife is fastened. This is drawn by one horse along the rows of standing corn. A device consisting of a bent iron rod leads the falling stalks onto the sled, with the butts all in one direction. When enough fodder for a shock is secured in this way, the horse is stopped and the stalks bound together. The same device is also used by some for cutting kafir corn.

Some of the corn is husked by hand from the standing stalks, the stalks afterwards being pastured. Part of the corn is also cut and husked by hand. Practically all of the corn that is fed to cattle is fed from the shock. The corn is cut and shocked in the usual manner, except that about 1 row in 25 is left standing and is known as the average row. The corn from it is husked and weighed. From this is computed the approximate amount of corn in a shock, and consequently the number of shocks for a given number of cattle. The small farmers and tenants usually sell their corn to the cattle feeders, most often by the acre.

In recent years the silo has become an important adjunct to the cattle-feeding industry. A large number were built during the present summer (1912). Into these the entire crop, both fodder and ears, is put. This method of preserving the crop is fast replacing the older plan of curing the fodder.

In comparatively recent years kafir has attained a position second only to that of Indian corn, and on a great many farms it is largely displacing the latter. This is not due to its superiority as a feed so much as to its better drought-resistant qualities and the consequent greater certainty of the crop. For kafir the ground is plowed in the spring and the seed drilled in the row much the same as with corn, though closer in the row. As kafir is seeded later than corn, it is often used in a field where an unsatisfactory stand of the latter is secured. Kafir is usually sowed the latter part of May or early in June. It is cultivated much the same as corn and harvested in the same way. Part of the crop is thrashed, the fodder and grain both being fed to cattle or hogs, but recently it has been used extensively as ensilage. As a feed, either as grain or as silage, it compares favorably with corn and in actual use it has proved very satisfactory. Chemical analyses show that the grain and fodder are about equal

to corn in nutrients, but are slightly less digestible. Feeding experiments show it to be worth from 80 to 87 per cent as much as corn for a feed. The statistics of the Kansas State Board of Agriculture for the year 1911 show 20,350 acres devoted to the crop in Greenwood County, whereas for the same year there were 99,705 acres of corn.

Two varieties of kafir are grown in the county, red and white, the white yielding the more abundantly. It is usually difficult to secure pure seed, as the two varieties cross-pollinate, and each crosses readily with sorghum.

Greenwood County is the second live-stock county in the State. More money comes in from this source than from any other. According to the Thirteenth Census, there were 72,805 head of cattle in the county, valued at \$2,736,101. Formerly, with the free range and cheap pastures, the cattle were all raised in the county, but with the increase in the value of the land it has proved more economical to buy steers from Texas and western Kansas when 2 and 3 years old. Sometimes they are contracted for several years in advance at a stipulated price. They are usually bought by the head and sold by weight. The larger part are brought in during the spring and put on the prairie-grass pastures, where they are fattened or "finished" for the fall market. These go on the market as "grass-fed" cattle. Others are brought in during the fall and "half fed" in lots through the winter, put on grass as early as possible in the spring, and finished for the market as early as July and August. The object of the half-feed plan is to carry the animals over the winter as cheaply as possible and to have them in the best possible condition to go on the pasture early in the spring and fatten quickly on the grass alone. The feed lots are in some protected place, usually in a wooded bottom along a stream, so that the cattle may have protection from the storms and a supply of good water. In the feed lots the herds range in size up to 150. The cattle are left on grass as long in the fall as the weather permits, the scanty pasture being supplemented by oil cake or other concentrates. The rations vary with different feeders. Corn is fed from the stalk without having been husked at the rate of 30 to 50 bushels per steer per winter. Oil cake is fed at the rate of 3.5 to 4 pounds a day. The roughage consists of corn fodder, silage, kafir fodder, millet, sorghum, and alfalfa. A few cattle are given full feed during the winter. These command a high price on the Kansas City market. In general, Greenwood County cattle have a special rating in this market. It is recognized that the cattle in the Flint Hills section fatten much quicker than those pastured elsewhere in the county.

Hogs are raised by practically all of the farmers and some of them make this line of husbandry more or less a specialty. Hogs are

usually run with cattle while the latter are on feed, and return a good profit as a side line. Some farmers feed herds of varying sizes for market independently of cattle. Duroc-Jersey and Poland-China are the most popular breeds, while some prefer the Berkshire. Herds of pure-bred animals of each of the breeds are maintained in various parts of the county. Cross-bred animals are also popular in the feed lot.

Horses and mules are raised by practically all of the farmers, though no farm is devoted solely to this industry. Several small herds of pure-bred Angus and Hereford cattle are kept in the county for breeding purposes; also several flocks of sheep, though the industry is of little importance.

The value of alfalfa has been recognized in comparatively recent years. In 1909 there were 14,570 acres devoted to the crop. Formerly it was confined to the bottom and valley soils, but during the last few years it has been successfully grown on the upland soils. Although the yields are lighter on the uplands than in the bottoms, the alfalfa grown on the uplands commands a higher price than that grown in the bottoms, because it is less woody and has less waste. With the exception of the loose, sandy soils in the southeastern part of the county, all of the soils will grow alfalfa or can be made to produce the crop by drainage. August seedings on a thoroughly prepared seed bed, free from weeds, have proved the most satisfactory. In favorable seasons a crop is obtained the same year. Seed is often secured from the second or third cuttings in dry seasons. Difficulty is often encountered with foxtail and crab grass in old fields and alfalfa is often killed out by them after three or four years. Most of the alfalfa is stacked in the field or stored in barns and sheds for feeding, only a small quantity of it being baled and sold.

The wild prairie grasses are the most abundant grasses in the county. They are used both for pasture and for hay. Bluestem is by far the most important species, but some buffalo grass occurs on the high prairie and a small amount of slough grass in the low and wet places. These prairie grasses come from the original sod. A small extent of rough land that was under cultivation but subsequently abandoned has grown up in the native grasses. A large quantity of prairie hay is made in the eastern part of the county from the more level areas. Most of this is baled in the field and either sold from the field or stored in large hay barns. During good seasons one ton per acre is often obtained, the average yield being about three-quarters of a ton. Tame grasses are not grown extensively. A limited acreage of timothy and also of timothy and red clover were seen during the survey. Red clover could be included in rotations to advantage. Sweet clover was seen along the roadside in nearly every part of the county, but no effort has been made to establish it in the pastures,

except in the northern part where it is being seeded in small quantities for hog pastures. It is said to be well suited for that purpose.

Fruit trees are grown on nearly every type of soil, but usually show signs of neglect. The fact that trees do well and bear satisfactorily under such conditions would seem to indicate that well-conducted orchards would be profitable.

Osage orange and catalpa are grown extensively for their wood and for the protection they afford from the prevailing winds. Oak, maple, walnut, elm, and cottonwood trees are also utilized for the latter purpose.

It is the opinion of old settlers that the land is less productive now than formerly and that the improved methods of cultivation have not offset the loss of the virgin fertility of the soil. This can best be explained by the fact that no rotation of crops has ever been practiced. The general practice is to keep the same piece of land in corn year after year until the yield becomes so small as to make its further production unprofitable. There are fields that have been in corn continuously since the early settlement of the section. It is owing to this practice of severe and injudicious cropping that the yields have decreased rather than to any marked decrease of the inherent fertility of the soil. Soils impoverished in this way often can be restored to their former condition of productivity simply by the practice of rotation and by improved methods of tillage. Each farmer should adopt a crop-rotation system which will answer the requirements of his farm and the types of soil occurring thereon. Alfalfa, cowpeas, or red clover should be included in every rotation to supply nitrogen to the soil, and manures should be applied when available. Cowpeas are not extensively grown, but can be fitted into many good rotations. They can be planted in corn after the last cultivation or after wheat in July, and mowed for hay in October, or they can be sowed in late spring with oats and cut for hay. The general practice is to drill them in rows in the spring, so that they may be cultivated and mowed for hay in the early fall (Pl. II, fig. 1). They may also be put in the silo along with corn. Whippoorwill and New Era are the best varieties for the county. Red clover sowed in wheat in the spring makes excellent pasture after the wheat has been harvested and may be mowed for two years. Corn, kafir, and sorghum should never be grown on the same land for more than two years in succession. Alfalfa is a good renovator, but is not adapted to short rotations. It is not profitable if it can not be left for more than three years. Red clover fits better into short rotations.

Until within the last few years a great deal of the manure made in the feed lots was wasted, the idea being to get rid of it in the easiest

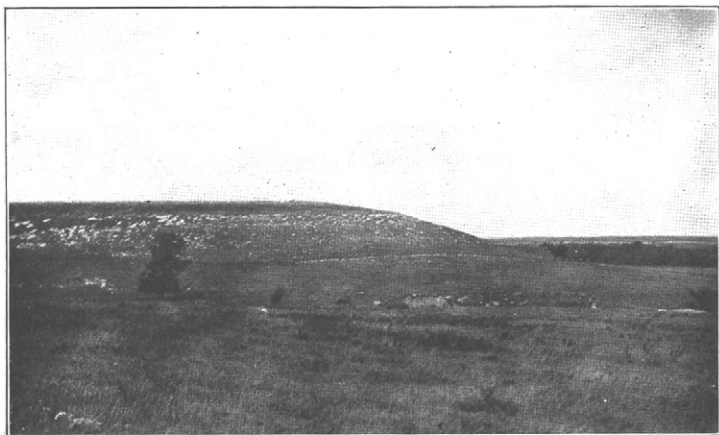


FIG. 1.—ESCARPMENT OF THE FLINT HILLS.
[Summit silty clay loam in foreground.]



FIG. 2.—A DRAINAGE CHANNEL IN THE FLINT HILLS.
[The general topography of this elevated section of the county is favorable to grazing.]

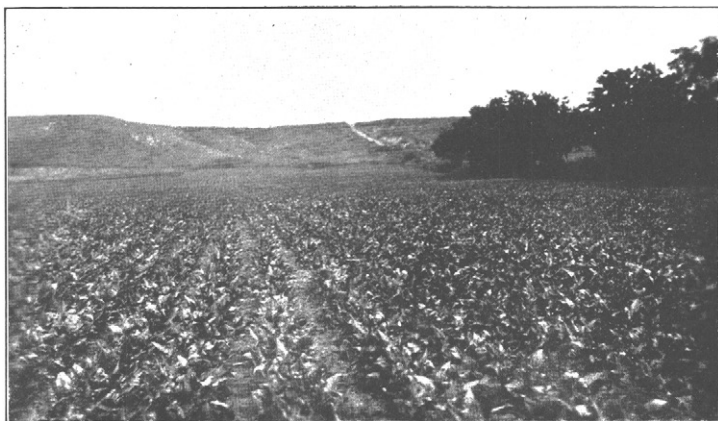


FIG. 1.—COWPEAS ON OSAGE LOAM AND SUMMIT SILTY CLAY LOAM.
[This crop is frequently drilled in row and cultivated.]

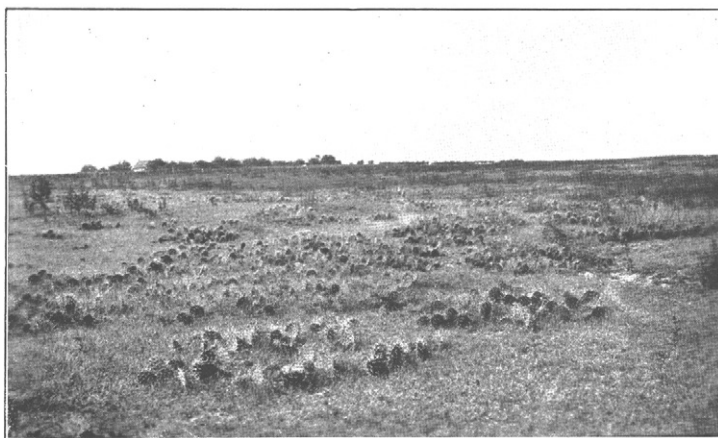


FIG. 2.—ALKALI SPOTS ON OSWEGO SILT LOAM, SUPPORTING GROWTH OF
CACTUS AND SALT GRASS.

way possible, but now the feed lots are usually cleared and the manure hauled to the fields. All manure should be protected from the weather and applied to the soil as soon as possible. On most farms the best way to handle manure is to haul it to the field and spread it daily, so that the soil may derive the benefits of the leaching and conserve the fertilizing elements that are lost through heating.

According to the Thirteenth Census, the average size of farms in the county is 285.8 acres, and the average area improved is 128.6 acres. From available statistics it appears that the number of farms in the county is decreasing. This condition is probably due in part to the fact that some of the land originally farmed is being allowed to go back into pasture and in part to the combining of small farms into larger holdings.

Cash rent for pasture land ranges from \$6 to \$8 per steer, and from 4 to 5 acres is usually required for each animal. Cash rents for farming land range from \$3 to \$5 per acre, and on the share basis the landlord receives about one-half the crop.

Land in the river bottoms is valued at about \$70 an acre, but local conditions, such as improvements, nearness to markets, condition of the land, etc., influence the price. Pasture lands range from \$18 to \$25 and upland farms from \$25 to \$40 an acre.

SOILS.

Greenwood County lies in the nonglaciated part of the western prairie region. Its upland soils are residual, or, in other words, derived directly from the underlying rocks, which belong largely to the Pennsylvanian division of the Carboniferous, although the highest terrace of the Flint Hills region is underlain by formations of Permian age. The eastern boundary of the Permian follows very close to the 1,500-foot contour.

The Pennsylvanian division of the Carboniferous consists of interbedded sandstone, limestone, and shale. Shale is the predominating rock. It may vary in texture from argillaceous to arenaceous in different beds, or even in the same stratum, in color from light gray to black, and in hardness from soft, micaceous shale to almost slate. The beds of sandstone and limestone are comparatively thin and uniform. Faulting and folding are nowhere in evidence. Were the present surface level, it is evident that the soils would be the same all over the county, but this condition has been altered by the effects of erosion, with the result that the different strata of rock have been exposed to the processes of weathering and soil formation at different levels. As different kinds of rock give rise to varying soil material, it is evident that an important relation exists between the topography and the soils, unlike soils being found at different levels where strata of unlike composition are exposed.

The rocks of Permian age consist mainly of limestone and chert. These lie above the rocks of the Pennsylvanian division of the Carboniferous, with an upland surface elevation about 1,500 feet above sea level. That division of the county underlain by these rocks represents high, smooth prairie land standing conspicuously above the surrounding country.

In the classification of the soils distinction has been made between the residual soils, according as the material is derived from shale and sandstone or from limestone, or combinations of these. Three upland or residual series of soils were established.

The Summit soils are characterized by the dark-brown to black color of the surface soil and by the yellow to yellowish-brown color and moderately crumbly structure of the subsoil. These are derived from interbedded limestone, sandstone, and shale. In places limestone constitutes the dominant portion of the parent rocks, while in others the proportion of shale is the greater. These soils generally occupy more sloping and ridgy areas than the Oswego.

The Oswego series is characterized by the black color of the surface soil, and the tough, compact structure and black to very dark brown color of the subsoil, which is a heavy clay. Generally the lower part of the subsoil is of a yellowish-brown color, and in places it contains enough incompletely decomposed material from the parent rocks to give it a crumbly structure. These soils are derived from sandstone and shale. There are places where they grade into soils including limestone material in their composition (Summit) in such a way that the boundaries can not be fixed with absolute certainty. The Oswego soils occupy basinlike, flat, and very gently sloping areas at varying elevations. They are less productive than the types placed in the Summit series.

The Crawford soils are derived from limestone, with probably some local influence from sandstone and shale. These are reddish-brown or dark-brown to red soils, underlain by dark-red to reddish-brown clay. Fragments of chert and lime concretions are of common occurrence on the surface and through the soil section. Well-drained flat and sloping areas and knolls or ridges are occupied by the Crawford soils.

The Boone stony sandy loam, the only member of this series in the county, is a brownish stony sandy loam, underlain by yellowish-brown to mottled yellow, yellowish-red, and grayish fine sandy clay. Bedrock of the parent sandstone is frequently encountered within the 3-foot section.

The overflowed first-bottom lands, or alluvial soils, are closely related to each other in the source of their material and the manner of their formation. The Osage silty clay loam occupies the narrower stream bottoms and higher portions of the wider bottoms, while the

Osage clay occupies depressions in the wider bottoms. The Osage soils are characterized by the dark color of the material of both the soil and subsoil. The material has been washed from the residual upland soils of the county and neighboring territory which the streams traverse. There is very little sandy material in the alluvial soils, clay and silt constituting their principal constituents. Along some of the streams are areas locally known as second bottoms. There is evidence to show that the material of these areas is not alluvial in origin but residual, and they were, therefore, grouped with the upland soils and correlated as the Oswego silty clay loam. Some of the first-bottom alluvium has been influenced by wash from adjacent slopes—colluvial material—and the Osage loam includes such areas.

In the subsequent chapters the several types are described in detail, and their agricultural value, crop adaptation, and other individual characteristics brought out.

The following table gives the names and extent of several soils. Their distribution is shown in the accompanying map.

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Summit silty clay loam.....	345,344	46.6	Osage loam.....	17,856	2.4
Oswego silt loam.....	96,000	12.9	Crawford silt loam.....	9,280	2.1
Summit clay loam.....	88,320	11.9	Dark phase.....	6,272	
Osage silty clay loam.....	59,136	8.0	Boone stony sandy loam.....	11,776	1.6
Summit stony loam.....	49,600	6.7	Summit gravelly loam.....	3,136	.4
Oswego silty clay loam.....	32,000	4.3	Osage clay.....	1,856	.3
Crawford gravelly loam.....	19,904	2.7	Crawford clay.....	640	.1
			Total.....	741,120	.....

OSWEGO SILT LOAM.

The surface soil of the Oswego silt loam consists of a black, very dark brown, or very dark gray, friable silt loam, about 8 or 10 inches deep. The subsoil is a black, heavy clay of a stiff, tough, waxy structure. Between the soil and subsoil there is usually a gradational layer of moderately friable, black silty clay loam, 2 or 3 inches thick. At 22 to 26 inches the color of the subsoil begins to get lighter, and below this depth there is a gradual brightening of the color from dark brown through dark yellowish brown to light yellowish brown. Material of the latter color usually appears at about 30 to 32 inches, though occasional borings show the darker colors predominating at 36 inches. The light-colored material consists of a less plastic clay, possessing a slight crumbly structure, caused by the presence of incompletely decomposed grayish rock material. In places the lower subsoil is slightly mottled with rusty brown and reddish yellow, re-

sulting principally from small oxide of iron concretions which are plentiful throughout the soil profile. Small lime concretions are also often found in the deep subsoil.

When wet this type takes on a uniform black color and is very sticky, and if disturbed while in this condition it tends to clod badly on drying out. Upon drying the soil tends to bake and pack, and unless it is well cultivated during the dry season it cracks badly, often causing considerable damage to growing crops by breaking the roots. The soil is locally known as "gumbo land," because of its stiff, sticky nature. It is also sometimes referred to as "hardpan" land, owing to the dense structure of the subsoil.

The Oswego silt loam has an extensive development on the divides between streams and occurs in practically every township east of the Flint Hills. It is a residual soil, derived largely from black, soft, argillaceous shale. So susceptible is this shale to the processes of weathering that no fragments are seen in the soil, and only in banks where it is more or less protected can it be found.

The characteristic topography of the type, which is level to gently rolling, is due largely to a thin bed of limestone which underlies the areas at varying depths and outcrops in places. This limestone acts as a horizontal support or platform upon which the type rests.

As a whole the Oswego silt loam is rather poorly drained. The flat, nearly level surface configuration does not favor a sufficiently rapid run-off of surface water, nor does the impervious nature of the subsoil permit the free downward movement of water. However, the position and topography of the type are such as to permit of easy drainage with tile drains. On some of the larger areas this could be accomplished more successfully and more economically on a large scale, as in that way a more satisfactory fall could be established for the easy flow of the water; otherwise the central portions of large areas might not have sufficient elevation above the surrounding land to insure thorough drainage even through tiles, so that large, long drains would be necessary. Not only is tile drainage beneficial for the removal of the excess water, but it causes the subsoil to become looser and more friable through aeration. Open ditches are sometimes used to remove the surface water, but they are of little benefit in aerating the subsoil.

Small spots of the Oswego silt loam, usually not over a few hundred feet in diameter, show alkali conditions. In such places the production of crops is difficult to impossible. They support a scanty growth of salt-loving grasses and dwarf cactus. (See Pl. II, fig. 2.) The alkali is usually in sufficient quantities to kill cultivated crops or to reduce greatly the yield. While heavy applications of manure will for the time being benefit grass or cultivated crops, the only permanent remedy is tile drainage. By this means the alkali may

be carried away in solution with the drainage water. The small "gumbo spots" or "buffalo wallows" that sometimes occur are caused by either the surface soil having been washed away, exposing the stiff subsoil, or by the soil having been puddled at some previous time. This condition can be rectified by the application of lime, which tends to flocculate the soil particles, followed by heavy applications of manure.

The original vegetation on the Oswego silt loam was prairie grass, which grew very rank. All of the general crops of the section are now grown upon it, though much of the type is still in grass, a large part of which is mowed for hay.

The most important factors controlling crop production on the Oswego silt loam besides drainage are the incorporation of organic matter in the soil and thorough cultivation. Though the soil is black it does not derive its color from the humus content. Deep plowing, with the resultant incorporation of humus, tends to make the soil more friable and to increase its moisture-holding capacity. The compact structure of the soil is indicative of high capillary power, and it is always advisable to maintain a dust mulch during the growing season to prevent the loss of soil moisture through evaporation.

The Oswego silt loam is one of the best upland corn soils in the county, but its value for this cereal is not generally recognized. The cause of many failures is insufficient cultivation during the growth of the plant and poorly prepared seed beds. Fall plowing is essential for the best yields. If the land is plowed deep enough to incorporate some of the stiff subsoil into the surface soil, there should be no trouble from drifting during winter. The soil is very difficult to handle, but when properly tilled it brings satisfactory results. Corn yields about 30 bushels and kafir about 35 bushels per acre. Alfalfa should do well on thoroughly drained areas, though most of the type is naturally too wet and soggy for this crop.

OSWEGO SILTY CLAY LOAM.

The Oswego silty clay loam consists of about 5 to 8 inches of a black silty clay loam, underlain by a black, tough, waxy clay. Occasional areas are found where the surface soil is a silt loam for 3 to 5 inches, though the tough black clay is always found at plow depth. At about 24 inches the subsoil is generally a dark-brown, waxy clay, and continues to become lighter in color with depth until at about 30 inches it grades into yellow or yellowish-brown sticky clay. Small black oxide of iron concretions usually occur in the subsoil, and occasional rusty-brown or reddish mottles in the deeper subsoil.

This type lies in the valleys along most of the larger streams and some of the smaller ones and is locally known as "gumbo land," or second bottom.

Like the Oswego silt loam, the Oswego silty clay loam is derived from the weathering of soft, black, argillaceous shale. Loose limestone fragments are present on the surface of some areas near their contact with the bottom-land soils. The type characteristically occupies a more nearly level and lower position than the Oswego silt loam.

A phase of the type occurs on the higher uplands differing from the valley soil only in its position. In the valley it is often difficult to determine where the Oswego silty clay loam leaves off and the bottom soils begin. In some cases there is a difference in elevation of a few feet. The type is never overflowed, though at times of continued rainfall the imperfect drainage is liable to retard the surface flow of water for a short time. Tile drains or open ditches are necessary to take care of the excess water. The natural slope from the upland to the bottom is sufficient for successful tile drainage, and the recommendations in regard to drainage under Oswego silt loam apply equally well to this type.

Corn and alfalfa are the principal crops grown on the Oswego silty clay loam. The yields are slightly larger than on the Oswego silt loam, probably owing to the difference in topography and its influence upon the moisture conditions. Corn averages about 25 bushels per acre and alfalfa about 1 ton per acre to the cutting, four cuttings being usually made. Kafir yields about 40 bushels per acre. The yield of both corn and kafir could be materially increased by a more thorough preparation of the seed bed and better cultivation. The land should be plowed as deep as possible, in the fall, exposing the impervious subsoil to the action of frost and air, and thoroughly disked very early in the spring.

Land of this type is valued at about \$50 an acre. It is practically all under cultivation.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Oswego silty clay loam:

Mechanical analyses of Oswego silty clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
381216.....	Soil.....	0.0	0.7	0.6	1.5	3.5	67.9	26.0
381217.....	Subsoil.....	.3	.7	.5	1.1	4.0	57.6	36.0

SUMMIT SILTY CLAY LOAM.

The Summit silty clay loam consists of a dark-brown to black, friable silty clay loam, underlain at an average depth of about 10 inches by brown or rusty-brown, moderately crumbly clay, which

usually becomes lighter in color with increase in depth, the lower portion being dark yellowish brown or yellowish brown faintly mottled with shades of yellow. The material becomes lighter in color and heavier in texture with increase in depth, though maintaining the granular structure to about 18 to 20 inches, where it disappears and the clay content begins to increase rapidly. In some cases, notably on slopes or sides of hills, the depth of the surface soil may be only about 6 inches, while on flat areas at the foot of slopes it may run as deep as 15 inches. A distinguishing characteristic of this material is its constant tendency to crumble and break into small aggregates, with the result that it does not tend to pack, bake, crack, or run together. At about 24 inches the material grades into a light yellowish brown clay, more plastic and tenacious than that immediately above it. Frequently the color of the deeper subsoil is yellowish green. Lime concretions and small, angular chert fragments are found in places throughout the soil profile, being more abundant in the subsoil. Black oxide of iron concretions frequently occur in the subsoil and are largely responsible for the mottled color of portions of it. Flat limestone rocks are scattered over the surface in places.

The Summit silty clay loam is one of the most important soils of the county, and has a larger area than any other type. It occurs in every township in the county, the most extensive areas lying to the east of the Flint Hills.

The type is of residual origin, being derived from the weathering of shale along with some limestone. Occurring both above and below the strata of shale are thin strata of limestone, which frequently outcrop on the steeper slopes. This associated limestone has influenced the soil more or less, but the proportion of limestone material present is probably small as compared with that derived from shale.

In the eastern part of the county, in Pleasant Grove and Salt Spring Townships, sandstone predominates over the limestone and outcrops of the former are common.

The topography is rolling to hilly, the type occupying ridges and gentle slopes, which form the sides of valleys. Occasional flat areas occur on the tops of hills, but the larger part of the type is found on the breaks of streams. Limestone outcrops and fragments are common on the steeper slopes about the heads of streams, and along stream courses. As far as possible these stony areas have been shown on the map, but in the more hilly sections only the larger areas and more prominent outcrops could be indicated.

The range of elevation at which the type occurs within the county is about 250 feet, the larger part of it lying at an elevation of about 1,000 feet. Natural drainage is fairly good, although the subsoil is

such that water does not penetrate it rapidly, and in many cases tile drainage would be beneficial. On steep slopes the soil washes badly and deep gullies are frequently seen.

Originally the type was prairie and supported a heavy growth of grass, but since the settling of the county trees for ornamental purposes have been planted locally, cottonwood, oak, maple, and box elder being used most extensively for the purpose.

When plowed the soil is loose and friable and easily tilled. The mellow surface, good drainage, and heavy subsoil make it well adapted to corn, and it is regarded as one of the best upland soils in the county. Corn yields about 30 bushels per acre. Kafir is displacing corn to a large extent. The former yields well and is superior to corn when the rainfall during the growing season is scant. Ordinarily yields of 30 to 40 bushels per acre are obtained.

A large part of the type is in grass and has never been plowed. The rougher areas are kept exclusively for pasture and support large herds of cattle during the greater part of the year. (See Pl. III, fig. 1.) The land is pastured at the rate of 4 or 5 acres to the steer. At that rate cattle gain from 200 to 400 pounds during the season, depending largely upon the moisture conditions and the condition of the cattle when they are put upon the pasture. The cattle receive no other feed than the grass during the summer.

A large acreage of the type is also left in grass for mowing. From the best areas in favorable seasons as much as a ton per acre of good prairie hay is secured but the average yield is about three-quarters of a ton.

Alfalfa is successfully grown on this type, but should only be planted on well-drained areas. Trouble has been experienced in securing a good stand the first seeding, probably because of the absence of those bacteria in the soil that promote the growth of the plant. Failures are sometimes caused by improper preparation of the seed bed. After several attempts a satisfactory stand is usually obtained. Three or four cuttings are made each year, averaging one-half to three-quarters of a ton each.

For general crops the Summit silty clay loam is one of the strongest soils in the county. It is valued at \$25 to \$40 an acre.

SUMMIT STONY LOAM.

The surface soil of the Summit stony loam is a dark-brown to black clay loam to clay, with an average depth of 6 to 8 inches. Bedrock is sometimes encountered at this depth; otherwise the subsoil consists of a yellowish-brown to grayish-yellow or yellowish-drab clay. The drab color usually becomes more intense with depth and at about 18 inches the dense subsoil gives way to a loose, ashy material of a light-gray color, consisting almost entirely of partly decomposed



FIG. 1.—CATTLE ON SUMMIT SILTY CLAY LOAM PASTURE.



FIG. 2.—ALFALFA ON OSAGE LOAM, FALL RIVER BOTTOM.

limestone. Loose limestone fragments are scattered over the surface and throughout the soil profile, and outcrops of soft, light-gray limestone are common, especially on the steeper slopes. Only the largest of these areas were shown on the map.

The type occupies undulating to hilly areas around the heads of streams and along the stream courses. It occurs on ridges and steep slopes and is confined entirely to the Flint Hills section of the county.

The soil material is derived from the interbedded shale and limestone that underlie the region. On some of the steep slopes the shale material has been removed by erosion, leaving only a slight covering over the rotten limestone, but on more level areas it has supplied the larger part of the material comprising the surface 18 inches. Many small bodies of the Summit clay loam occur within large bodies of the Summit stony loam, usually on level areas between streams, but in most cases they were too small to show on the map.

As a whole, the Summit stony loam is too rough for cultivation, though small, scattered areas were seen that could possibly be plowed. The value of the soil lies in the grass that it produces. Although slightly inferior to the Summit clay loam in this respect, it supports a heavy mat of prairie grass, except in places where the bedrock is at or near the surface. The grass grown upon this type has the same feeding value as that grown upon the Summit clay loam.

The type as a whole is well watered, which adds to its value for pasture. Land sells for \$18 to \$25 and rents for about \$1.50 an acre.

SUMMIT CLAY LOAM.

The Summit clay loam consists of a black clay loam or heavy clay loam of moderately friable structure, underlain at about 6 to 8 inches by nearly black stiff clay, which becomes lighter in color with increase in depth, grading through dark yellowish brown and yellowish-brown clay into yellow or greenish-yellow stiff, plastic clay at about 28 inches. In places the yellow of the subsoil is replaced by drab, in which case the color grades from dark brown through brownish drab to drab. Occasional borings show slight mottlings of rusty brown in the deep subsoil. Small black iron concretions are sometimes found in the subsoil and lime concretions are not infrequent. Bedrock is often encountered within the 3-foot section, in places interfering with cultivation, and flat limestone fragments are scattered over the surface and throughout the soil section. Limestone outcrops are also frequent on steep slopes. The subsoil in places contains sufficient partly decomposed gray limestone material to give it an ashy feel. As far as possible such areas were separated and mapped with the Summit stony loam, though some were too narrow to show on the map.

The Summit clay loam is derived from interbedded shale and limestone, the shale having entered more largely into the formation of the material than the limestone. The type is confined entirely to the Flint Hills section of the county and comprises a large area in that region. It occurs at elevations ranging from about 1,250 to 1,400 feet above sea level. Practically all of the less stony areas within this range of elevation are included in this type.

Though the subsoil is rather impervious to the downward movement of water, the type is well drained. It is fairly retentive of moisture, but during periods of protracted rainfall tends to pack badly.

Very little of the Summit clay loam is under cultivation, and some of the areas that have been plowed are being turned back to sod for pasture, as it is considered one of the best soils of the section for this purpose and yields a much greater return from that source than from cultivated crops. Yields of 20 bushels of corn are considered good. Kafir, which has displaced corn to a large extent, averages about 30 bushels to the acre. The grass produced on this type is considered superior in fattening qualities to that grown upon the lighter soils and pastures on it rent for about 25 cents per acre more than on the lighter soils. Steers have been reported to make gains of 500 pounds each in a single season on the pastures of this type. Though this gain is exceptional and due largely to the poor condition of the cattle when pastured in the spring, as well as to an exceptional season, gains of 300 pounds are common.

Most of the type is held in large tracts for pasturage and very seldom changes hands. Its value is influenced by the price of cattle, but of late years the selling price has ranged from \$18 to \$25 an acre and the renting price from \$1.50 to \$1.75 an acre.

SUMMIT GRAVELLY LOAM.

The Summit gravelly loam to a depth of 6 to 8 inches is a black or dark-brown silty clay loam. Below this yellowish-brown clay loam is encountered. At about 24 inches the clay loam passes into a yellow or yellowish-gray plastic clay. Angular fragments of chert and flattish fragments of limestone are abundant, occurring scattered over the surface and throughout the soil profile. Lime concretions are also present in places. Sometimes the chert fragments are absent on the surface and occur as a stratum between the surface soil and subsoil. Included in the type are small patches of Crawford gravelly loam too small to separate.

The type occupies gentle slopes and flat areas near streams. The largest body is in the northeastern part of the county, in Shell Lock Township. There are also areas in Madison Township, north of the Verdigris River.

The Summit gravelly loam is derived from shale and limestone. Strata of chert or cherty limestone are interbedded with the shale, but the chert being more resistant to the processes of weathering, has entered less into the formation of the soil than the soft and more susceptible shale.

The general nature of the subsoil insures thorough drainage. In places the drainage is excessive, and crops, including grass, suffer from lack of moisture. The type is of little agricultural value, and only a small proportion of it is cultivated, the large amount of chert on or near the surface making cultivation difficult. Corn yields about 20 bushels per acre. The steeper areas are used entirely for pasture, but most of those areas whose topography permits of the use of hay-making machinery are mowed.

CRAWFORD SILT LOAM.

To a depth varying from about 6 to 12 inches the Crawford silt loam consists of a reddish-brown silt loam of a friable structure. This surface portion grades into a heavy red clay loam, which becomes heavier with increase in depth, passing at about 18 inches into bright-red, sticky, plastic, clay of a dense structure. Except for a slight brownish cast, the soil closely resembles the Summit soils, being mellow and granular and easily tilled. The parent limestone rock is encountered anywhere from about 12 inches downward. Flat limestone fragments are scattered over the surface and disseminated throughout the soil section. Lime concretions are also common over the surface and in the soil mass. Limestone outcrops are frequent.

The type occupies flat to gently rolling areas and occurs most commonly on shelf-like situations overlooking stream valleys. Occasional areas are found on the flat tops of limestone hills. Small, isolated areas occur within bodies of the Summit silty clay loam, especially in proximity to limestone outcrops. Many of these were too small to map. Where the higher upland breaks away to the stream valleys, a narrow fringe of Crawford silt loam usually occurs adjacent to the limestone outcrop.

This type of soil is derived mainly from limestone. The subsoil is no doubt true limestone material derived from the underlying rocks, but the soil in places probably represents a mixture of shale material with material of limestone origin. The type is naturally well drained. When wet the soil becomes sticky and plastic, but when exposed to the action of air and frost, it breaks down into a crumbly, mellow structure. It is usually well supplied with organic matter.

Because of its shallowness, the type is droughty and crops, including grass, often suffer from lack of moisture. On the areas of deeper soil, or where the bedrock is not less than 24 inches below the

surface, corn and Kafir do well, the yields being about the same or slightly larger than on the Summit silty clay loam. Most of the type, however, is used for pasture. Some of the grass is mowed for hay, the yield in good seasons being about 1 ton per acre. Corn yields about 25 bushels and Kafir about 30 to 35 bushels per acre. Deeper plowing is recommended for areas where the depth to bedrock is sufficient to permit it.

Crawford silt loam, dark phase.—The surface soil of the dark phase of the Crawford silt loam is a dark-brown or dark reddish brown, friable silt loam. This is underlain at depths ranging from 8 to 18 inches by a dark chocolate brown or dark reddish brown to dark chocolate red stiff, tough, heavy clay. In places the subsoil is yellowish brown or yellowish red in color. On account of the loose, light nature of the surface soil, the type is very susceptible to erosion where the topography is at all steep.

This phase is confined wholly to the Flint Hills, in the western part of the county and occupies a broad, nearly level plateau, standing 50 to 100 feet above the surrounding country.

The soil material was derived from limestone and cherty limestone of Permian age. Usually a stratum of large angular chert gravel is encountered at a depth of about 24 inches. Chert gravel is also often found scattered over the surface and disseminated throughout the soil profile.

The dark phase is well drained and a large part of it is suitable for cultivation. Practically the whole of it is at present in grass. It is one of the best grass soils of the county, and although it does not support as heavy a sod as the Summit clay loam, the quality of the grass is equally as good. Very little of the phase has ever been plowed. Small, isolated patches of corn and kafir are the only crops grown. Corn yields about 25 bushels and kafir about 30 bushels per acre. Both crops are liable to damage from the winds, as the topography affords no protection. If ample protection from the high winds could be established, apple trees and small fruits should do well.

Land of this phase is worth from \$18 to \$25 an acre. It rents for \$1.50 to \$1.75 an acre for pasture.

CRAWFORD GRAVELLY LOAM.

The Crawford gravelly loam consists of about 6 inches of dark-brown to almost black loam or silt loam, underlain by reddish-brown to red clay. Angular chert ("flint") fragments are usually scattered over the surface and throughout the soil section. Occasional nearly flat areas are encountered that are almost free from chert on the surface, but in such places there is a stratum of chert between the soil and the subsoil and gravel is thoroughly disseminated throughout the subsoil.

The type is confined to the Flint Hills and occupies steep slopes adjacent to broad, level plateaus, consisting of the dark phase of the Crawford silt loam, and the gentle slopes of stream valleys within the latter type.

Like the other soils of the Crawford series, the gravelly loam is derived from limestone or cherty limestone. The chert, being more resistant to the processes of weathering, has entered less into the composition of the material than the limestone, much of it remaining in the shape of fragments.

The drainage of the type is good, this being favored by position and the presence of chert gravel.

The type is used wholly for pasture, the chert content being sufficient seriously to interfere with cultivation and the prevailing topography being unfavorable for the production of crops. It produces grass of an excellent quality, although the growth is not so abundant as in the other soils of the section. Land of this type brings from \$18 to \$25 an acre.

CRAWFORD CLAY.

The Crawford clay consists of a heavy clay loam or clay of a peculiar dark chocolate brown or dark chocolate red color, underlain at about 6 inches by a heavy, plastic clay of a somewhat lighter color. When wet the soil is sticky and plastic, but upon drying out it becomes loose and pervious. Partially decayed limestone and shale fragments of a pronounced greenish color occur throughout the soil section, and in places give a green tinge to the soil and subsoil. Limestone fragments and lime concretions are scattered over the surface and disseminated throughout the soil profile. Limestone outcrops are prevalent.

Only one area of the Crawford clay was mapped. Small areas of the type are common within bodies of the Summit silty clay loam in close proximity to limestone outcrops, but these are of little importance and of small extent and could not be shown on the map. The area mapped is located in the northeast corner of Pleasant Grove Township.

The topography is hilly to steep. This area lies at an elevation of about 1,000 feet above sea level, overlooking the Verdigris Valley. The drainage is good, though not excessive, and the soil retains moisture well during periods of protracted rainfall. All of the type is devoted to grazing.

BOONE STONY SANDY LOAM.

The Boone stony sandy loam is a loose, brown loamy fine sand or fine sandy loam, underlain at about 8 to 10 inches by light-brown, yellowish-brown, or reddish-brown heavy fine sandy loam or light fine sandy clay. Occasional areas occur where the lower subsoil is

mottled yellow, yellowish red and gray. Bedrock lies usually anywhere from 8 to 24 inches below the surface and it is seldom possible to bore to a depth greater than 36 inches. Fine mica flakes are abundant in the subsoil. Fragments of sandstone are scattered over the surface and outcroppings of the same rock are abundant.

Small isolated areas of this type occur throughout the eastern part of the county, especially along the walls of the Verdigris Valley, but the greatest development is in the southeastern part, between the valleys of Fall River and the Verdigris River. Its general elevation is about 1,050 feet above sea level.

The Boone stony sandy loam is derived from a soft, fine-grained micaceous, reddish-yellow to reddish-brown sandstone.

The prevailing topography is steep, the type occupying slopes and ridges. Erosion has caused considerable dissection. Gullies of considerable depth and with steep, precipitous sides are of common occurrence.

Drainage is well established and even excessive on the shallower areas. Grass usually suffers from drought. The type as a whole is deficient in organic matter and should be improved by frequent heavy applications of stable manure and the plowing under of leguminous crops. For the best results the manure should be incorporated with the soil as deeply as possible.

The Boone stony sandy loam is forested with a dense growth of stunted oak, mainly blackjack. Prairie grass grows in the openings, but is frequently killed out over large areas by the dense shade of the encroaching forest growth. When the land is used for pasture it is necessary to cut back the trees, so that the grass may have a chance to grow.

The type is of little agricultural value. Corn yields about 15 bushels per acre.

OSAGE CLAY.

The Osage clay consists of a tough, intractable, black heavy clay loam or clay, about 8 inches deep, underlain by a black to bluish-black, tough, plastic, impervious clay. Occasional borings show the color of the deeper subsoil to be a very dark drab, with a decidedly bluish tinge.

There are only four small areas of the type in the county. These lie at the outer edge of the Verdigris River bottoms adjacent to the upland. The largest area lies just east of Madison, another at Virgil, and two south of Quincy. The topography varies from level to slightly depressed.

This soil is of alluvial origin. It is naturally wet and soggy, and unless artificially drained, of little value. In places it receives seepage water from the adjacent uplands, and such areas remain wet and soggy throughout the year.

On drained areas of the type corn yields 60 bushels per acre. Wheat yields 30 bushels, but the growth of the straw is too rank for successful production. The soil is usually too wet for alfalfa.

Although too heavy to be worked when the moisture content is high, when exposed to the action of air and frost the soil and subsoil break up into a friable condition, closely resembling "buckshot" structure. Applications of lime and manure would have a beneficial effect on the texture.

The original forest growth on the Osage clay consisted of walnut, oak, hickory, and sycamore.

The price asked for land of this type varies from \$30 to \$100 an acre, depending on the drainage conditions.

OSAGE SILTY CLAY LOAM.

The Osage silty clay loam to a depth averaging about 12 inches consists of a dark-brown to almost black silty clay loam. The subsoil is a light-brown silty clay loam or heavy silt loam. There is usually very little change from the surface soil to the subsoil, the most marked difference being in the slightly darker color of the former, owing to its higher content of organic matter.

Along Walnut Creek there occurs a phase of the type in which the content of very fine sand is greater than elsewhere. The difference is not sufficient, however, to justify its being mapped as a very fine sandy loam.

The Osage silty clay loam is a first-bottom soil lying along the Fall and Verdigris Rivers and their larger tributaries. The soil is of alluvial origin, having been formed by the deposition of sediments washed from the uplands occurring in the drainage basins of the several streams. The topography is flat, with a very gentle slope to the streams, and practically all of the type is subject to overflow during periods of heavy rainfall. The overflows are of short duration, however, and as the gently sloping topography and porous nature of the soil and subsoil favor rapid drainage the bottoms are practically free from surface water within a short time after the streams subside. Occasional depressed areas are seen that would be benefited by tile drainage, but most of the type is adequately drained.

The Osage silty clay loam is the most valuable type and the best corn and alfalfa soil of the county. Some fields have produced crops of corn for 30 years or more, and though the yields are annually decreasing, they are still profitable. Such fields, after being kept in alfalfa four or five years and again planted to corn produce yields that rank favorably with those secured from the virgin soil. Heavy applications of manure are also beneficial in restoring such land. Corn on the average yields about 50 bushels per acre. Alfalfa does exceptionally well and a large part of the type is sowed to this crop.

Four cuttings averaging about 1 ton an acre are obtained each year. Seed is often obtained from the second or third cutting. In the eastern part of the county wheat is grown on this soil, the yield ordinarily ranging from 25 to 30 bushels per acre. A small acreage is planted to Irish potatoes, which yield at the rate of 100 to 150 bushels per acre. The crop is consumed locally. Some kafir is grown, though that crop is more often found on the uplands.

Originally the Osage silty clay loam was covered with thick forests, consisting mainly of oak, elm, walnut, hickory, sycamore, box elder, maple, and cottonwood. A small extent of rough land along the streams is still in forest, but most of the type is under cultivation.

The Osage silty clay loam is valued at about \$70 an acre. Some favorably located and well-improved farms sell for as much as \$100 an acre. The usual rent for land of this type is \$5 an acre, or on shares, one-half the crop.

The results of mechanical analyses of samples of the soil and subsoil are given in the following table:

Mechanical analyses of Osage silty clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
381214.....	Soil.....	0.0	0.1	0.2	2.3	11.4	55.8	30.2
381215.....	Subsoil.....	.0	.1	.3	2.5	8.9	64.0	24.5

The following samples contained more than one-half of 1 per cent calcium carbonate (CaCO_3): No. 381214, 4.72 per cent; No. 381215, 5.79 per cent.

OSAGE LOAM.

The Osage loam is the most variable soil in the county. Usually it consists of 8 to 18 inches of a dark-brown to black loam, underlain by a slightly heavier loam or silty clay loam of about the same color. The line of demarcation between the soil and subsoil is not distinct and in some places it is impossible to say where the surface soil ends and the subsoil begins. In all cases the soil and subsoil are very much alike.

The soil is colluvial in origin and varies somewhat in color and texture, according to the color and texture of the soils on the adjacent higher elevations. The topography is level, the type occupying narrow depressions along streams, near their heads. It occupies a position very little higher than the local drainage channels and is found in all parts of the county. When the streams become large enough to overflow their banks the soils of alluvial origin occupy the bottoms and displace this colluvial type.

The Osage loam is formed by the gentle wash and creep of material down the slopes. This movement is aided by gravity, by water,

and by freezing and thawing. The depth of soil is usually greatest at the foot of the slopes, gradually thinning with rise in elevation.

The type has a limited extent. The areas, which lie on both sides of the streams, are very narrow, and the drainage channels are usually too deep to be crossed by teams and agricultural implements. The crops are governed entirely by those upon the adjacent uplands. When plowed, the type is subject to erosion and deep gullies are common, but the soil is easily tilled and productive. Corn yields about 30 bushels and Kafir about 40 bushels per acre. Alfalfa also does well. (See Pl. III, fig. 2.)

SUMMARY.

Greenwood County is located in southeastern Kansas. It has an area of 1,158 square miles, or 741,120 acres.

The topography is gently rolling to hilly, with rougher areas along the streams and in the Flint Hills region.

Drainage is through the Verdigris and Fall Rivers and their tributaries. The former flows through the eastern part of the county, and the latter crosses the central part.

The first settlement in the county took place along the Verdigris River in 1856. The county was organized in 1862. The present population of 16,060 is largely rural. Eureka, the county seat, is the largest town. Madison is next in size. Many smaller towns are scattered through the county.

Railroad facilities are available in all parts of the county.

Kansas City, about 160 miles northeast of the county, is the principal market.

The climate is humid and adapted to the production of general farm crops.

The fattening and marketing of live stock is the most important industry in the county.

The principal crops, named in about the order of their importance, are corn, alfalfa, kafir, wheat, sorghum, oats, millet, and cowpeas.

Excepting wheat, the bulk of the crops enumerated are used to feed live stock.

No systematic rotation of crops is practiced.

The number of farms in the county is decreasing. Land sells for \$15 to \$70 an acre. Most of the land is rented for cash, the rate ranging from \$3 to \$5 an acre. On the share basis the landlord takes one-half the crop.

There are 13 types of soil in the county. Most of these are residual in origin. The others are alluvial and colluvial types lying along stream valleys.

The Oswego silt loam occupies level topography on the divides between streams and is locally known as "gumbo land" or "hard-

pan land." The type is deficient in drainage. It is a good corn soil and when drained will grow good alfalfa.

The Oswego silty clay loam resembles the silt loam, but is a heavier soil and occurs sometimes in the stream valleys. It also occupies parts of the stream divides.

The Summit silty clay loam is the predominating type and is adapted to corn, wheat, and alfalfa. A large part of the type is in pasture and supports a heavy growth of grass.

The Summit clay loam is found in the Flint Hills section of the county and is almost all in grass.

The Summit stony loam and the Crawford gravelly loam are confined to the Flint Hills and are valued only for the grass that they produce. They are too rough for cultivation.

The Summit gravelly loam occurs in the northeastern part of the county, and most of it is too rough for farming.

The Crawford silt loam and its dark phase are of limestone origin and have red to reddish-brown subsoils. The main type is under cultivation, while the phase which is confined to the Flint Hills is all in grass.

The Crawford clay is of small extent and is used for pasture. Small areas of the type often occur near limestone outcrops.

The Boone stony sandy loam is a reddish-yellow soil derived from the soft, micaceous sandstone that outcrops in the southeastern part of the county. The type is forested with scrub oak, but affords some grazing.

The Osage silty clay loam is the highest priced land and the best corn and alfalfa soil in the county. It occurs along all the larger streams.

The Osage clay, which occurs in the Verdigris River bottoms, is of little value in its natural condition. With artificial drainage the type is productive. Corn ordinarily yields 60 bushels per acre.

The Osage loam is of colluvial origin and occurs along the headwaters of the smaller streams. The type is not subject to overflow. It is of little agricultural importance, because of the narrow areas in which it occurs.



[PUBLIC RESOLUTION—No. 9.]

JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, be amended by striking out all after the resolving clause and inserting in lieu thereof the following:

That there shall be printed ten thousand five hundred copies of the report on field operations of the Division of Soils, Department of Agriculture, of which one thousand five hundred copies shall be for the use of the Senate, three thousand copies for the use of the House of Representatives, and six thousand copies for the use of the Department of Agriculture: *Provided*, That in addition to the number of copies above provided for there shall be printed, as soon as the manuscript can be prepared, with the necessary maps and illustrations to accompany it, a report on each area surveyed, in the form of advance sheets, bound in paper covers, of which five hundred copies shall be for the use of each Senator from the State, two thousand copies for the use of each Representative for the congressional district or districts in which the survey is made, and one thousand copies for the use of the Department of Agriculture.

Approved, March 14, 1904.

On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils.]

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